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ABSTRACT

This report offers the premise that a psychology of reading instruction has a set of questions of its own, questions that concern the ways in which the environmental interventions called instruction interact with cognitive processes to modify competence. The report discusses two streams of psychological research as they relate to reading instruction: that of the cognitive psychologists and that of the learning psychologists. Sections of the report include discussions of skilled performance and acquisition, individual differences, and inventions and discovery in learning to read. Suggestions for continued study are also offered, and include contrastive studies of good and poor readers, longitudinal studies of reading development, readiness and aptitude matching, and inquiries into who is likely to invent reading and who seems to need very explicit instruction. The report concludes that a great deal more must be learned about the relationship between skilled performance in reading and patterns of acquisition, and that more must be learned about how development is modified by environmental events, particular instruction. (MKM)

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TOWARD A USABLE PSYCHOLOGY OF READING INSTRUCTION

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Toward a Usable Psychology of Reading Instruction

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The last decade has witnessed a remarkable renewal of interest among psychologists in the psychology of reading processes. Major works have been devoted to the psychology of reading, and several psychologists have heralded a return, after 50 or so years of neglect, to active concern with describing the processes of reading (Gibson & Levin, 1975; Venezky, 1977). But even while celebrating this renewed attention to reading, certain cognitive psychologists have expressed doubt about whether basic research on reading will have much to say, in a direct way, about instruction. Gibson and Levin, whose book on the psychology of reading has done much to both mark and advance the growing interest of psychologists in reading, question whether their research can, "in the end, help children learn to read [p.xi]." The present volumes were specifically intended to explore and document the contributions of basic research in the psychology of reading to reading instruction. Yet, even here, doubts about the present and the possible contributions of psychological research are expressed, not only by the more practically oriented contributors (see, for example, the chapter by Clay, Vol. 2) but also by psychologists themselves (e.g., Kintsch, Vol. 1; Smith & Kleiman, and Venezky, Vol. 2). Why should it be the case that even those who have made a considerable contribution to understanding the processes of reading are so uncertain about the contributions of their own and their colleagues' work to reading instruction? Why is linking the theory-based research effort to the largely intuitively driven instructional effort so difficult?

Reviewing the various chapters of these volumes has led me to understand these difficulties better. The task has made it clear to me that the psychology of reading *instruction* cannot be simply the psychology of reading processes

"applied" to education. Instead, the psychology of reading instruction has a set of questions of its own, questions that concern the ways in which the environmental interventions we call instruction interact with cognitive processes to modify competence. The bulk of the present chapter illustrates this point by presenting some of the questions a psychology of reading instruction must address and by considering how the attempt to answer these questions may require us to modify our traditional research approaches. Before turning to this task, however, it is worth pausing to consider the forces within the field of psychology that have contributed to its present difficulty in addressing questions of instruction in reading.

TWO STREAMS OF PSYCHOLOGICAL RESEARCH

When, in the early 1960s, American psychologists began once again to turn their attention to questions of education, two groups of psychologists—the "established" learning psychologists and the nascent cognitive psychologists—vied for preeminence. Learning psychologists (especially Skinner, and those who developed his interest in instructional technology) and the cognitive psychologists (Jerome Bruner and George Miller, for example) recommended very different prescriptions for improving educational practice and for conducting psychological research on instruction. But it is not often recognized that the two branches of psychology were actually addressing different sets of instructional issues.

Most research in cognitive psychology has been largely concerned with describing mental processes in what can be described as steady-state situations. In the growing body of cognitive task analyses (see Resnick, 1976, for an analysis of the forms that task analysis has taken in cognitive/instructional psychology), for example, what is modeled or described is typically a "snapshot" of task performance. Although temporally organized processes are recognized, models of cognitive performance assume that no important changes occur *during the period being modeled*. It is true that in many cognitive studies, data are examined for practice effects—that is, for the possibility that subjects perform differently in later than in earlier trials. However, evidence of a practice effect usually leads the cognitive psychologist to drop early trials from the data analysis (because they do not represent full competence) or, at best, to give separate descriptions of earlier and later performance. Thus, even when changes in processing in the course of performance have been recognized, there has usually been no attempt to describe the processes involved in the *transition* from one kind of processing to another.

This general characterization is as true of developmental studies of cognition as it is of studies of a single age group. Although developmental

studies typically compare performances at different ages, the descriptions for any one age are steady-state descriptions. There is at the present time no well-developed theory of *acquisition* within developmental psychology, although cognitive psychologists have begun to note the need for theories of transition and thus of learning (e.g., Trabasso's chapter, Vol. 3; and Anderson, Kline, & Beasley, in press; Estes, 1976).

Cognitive psychology's lack of concern with transitions in competence must be contrasted with traditional learning psychology's pervasive interest in transitions. Learning theories had weak or nonexistent descriptions of what goes on, mentally, during a given performance, but they did develop detailed descriptions of external events that lead to changes in performance. In fact, learning was defined in these theories as a change in performance, and research attention was directed to what produced the changes (practice, timing, stimulus conditions, rewards, etc.). Some learning psychologies—particularly operant psychology—were especially concerned with arranging environmental events so as to enhance learning; these branches of psychology can appropriately be called *intervention sciences*.

We have within psychology, then, two kinds of thinking about instructional matters. In one, detailed attention is paid to what the processes of cognition are, but the transition from one level of competence to another is largely ignored. In the other, the conditions that produce transitions are described quite carefully, but the nature of the mental processes themselves is ignored. Recent research on reading processes is clearly rooted in cognitive rather than learning psychology. As a result, this research has for the most part been unable to address directly the general question of how reading skill is acquired, or the more particular question of how intervention can foster the acquisition of this skill. A psychology of instruction, in reading or any other subject matter, cannot neglect these questions; they lie at the heart of instructional psychology. On the other hand, we cannot simply return to the old learning psychology, for a psychology of instruction cannot omit, in the way that learning psychology did, detailed descriptions of skilled, novice, and intermediate levels of performance. Descriptions of performance provide, at the least, the landmarks by which instruction can be monitored—the eventual goals of instruction and some of the intermediate points en route. What is needed, then, for a viable and usable psychology of reading instruction is a joining of cognitive psychology and certain aspects of learning psychology to create a cognitive psychology of learning.

I attempt in the remainder of this chapter to consider: (1) what a psychology of reading instruction that joins these two lines of psychological thought might be like; and (2) where we stand with respect to its development. I do this in relation to a number of issues that seem to me to be promising, perhaps even essential, for a new instructional psychology of reading. These include: (1) the role of developmental research in elucidating the relationship

between skilled performance and the acquisition of reading skill; (2) the relationship between individual differences and instruction in reading; and (3) the role of invention and discovery in learning to read. In the course of the discussion, I suggest how cognitive and learning psychology might draw upon each other in responding to these issues.

SKILLED PERFORMANCE AND ACQUISITION: THE QUESTION OF DEVELOPMENT

Much of the current research on reading processes focuses on skilled performance, and many chapters in these volumes reflect this predominant concern. Research is reported here on how information is acquired from the written text, how this new information is related to information already held by the individual, how strategies are used in interacting with a text, and so forth. The individuals studied in most of this research already know how to read, usually with considerable skill. Research of this kind can be thought of as psychological task analysis; it is designed to determine empirically how people actually perform aspects of a complex family of tasks that we call reading. Kintsch (Vol. 1) calls for an extension and elaboration of this kind of task analysis as a basis of instructional design, and this call is implicitly echoed in the comments and analyses of several other contributors. One can hardly disagree that the psychology of instruction must attend to the nature of skilled performance as a kind of target toward which instruction must work. Nevertheless, I do not believe that an understanding of skilled task performance will, by itself, produce the recommendations for instructional practice that we seek. Knowing how skilled readers read may not automatically tell us what should be taught to beginners. Instead, novices may need to proceed through stages of acquisition and development in which their performance is quite different from skilled performance.

Failure to distinguish between skilled performance and performances useful during acquisition and instruction is part of the reason that today's psychology of reading does not always illuminate questions of instruction. A good example is the debate, actively pursued in the pages of these volumes, over direct versus mediated access to meaning. The question generally posed is whether skilled readers translate printed material into a phonemic representation, which in turn allows them to recognize a meaningful word, or whether they directly access meaning from the print itself. It is sometimes assumed that resolution of the question with respect to skilled readers will prescribe the extent of instruction in "code-breaking" (translating print into sound) that beginning readers should receive. An assumption is implicitly made, in other words, that performance during the acquisition of a skill is simply a less smooth version of skilled performance, and that what we teach

the novice should match as directly as possible the processes that the expert will employ. But even if we suppose, for the sake of argument, that skilled readers access meaning directly from print, it does not necessarily mean that beginning readers will not profit from instruction in phonemic translation skills. In fact, it is quite possible that the only way to become a skilled reader—one who can bypass phonemic translation—is to learn the process of phonemic translation first.

Venezky and Massaro (Vol. 1) suggest how this might work. They argue that skilled readers respond directly to information carried in spelling patterns of the language, without any translation to phonemic form. This orthographic information, in other words, leads directly to meaning. Responding to orthographic information, however, requires the reader to attend to patterns of letter grouping and letter order—the same patterns that must be attended to in learning phonemic translation skills. On the basis of this analysis, Venezky and Massaro propose that an excellent, and perhaps the only, way of learning to use the orthographic information of the language is to learn phonemic decoding.

It is important to note that Venezky and Massaro's suggestion that code instruction, with its demands for phonemic translation, may assist people in acquiring the ability to access meaning directly from print is essentially an inference from analysis of skilled reading performance. They have not attempted to trace experimentally a course of development in which eventual skill in picking up orthographic information depends on having early experience in phonemic decoding. A developmental research program of this kind is what would be needed to establish empirically their claim that code or phonics instruction is an important step in developing skill in reading, even though skilled reading does not necessarily include phonemic translation of print.

It is perhaps not surprising that a new claim such as Venezky and Massaro's is not yet supported by developmental studies. What is surprising is how little developmental knowledge we have of any aspects of reading. Gibson and Levin (1975), in their detailed interpretive review of the literature on the psychology of reading, describe studies on the development of visual perception and general cognitive strategies but report few developmental studies of the reading process itself. Doehring's (1976) report of changes in word-processing skills between kindergarten and 11th grade probably represents the most extensive data base on the development of reading processes now in existence. In these volumes, only a few chapters directly address developmental concerns. Smith and Kleiman's (Vol. 2) extensive and thorough review of research on word-recognition processes, for example, touches hardly at all on how these processes develop. Only two chapters (Juola, Schadler, Chabot, McCaughey, & Wait, Vol. 2; Liberman & Shankweiler, Vol. 2) are explicitly concerned with the development of word-

recognition skill. Juola et al. found that second graders were already performing like adults, and quite differently from the nonreading kindergartners, on a set of word-recognition and visual-search tasks. As these authors suggest, investigations of changes in word-recognition processes in the critical early months of learning to read are needed. Also needed is an extension of this kind of cross-age comparison to more complex processes that may show developmental shifts later in the learning process. Research of this kind is reported by Liberman and Shankweiler (Vol. 2), who found changes in specific kinds of oral-reading errors over the second- through fourth-grade period.

Cross-age comparisons such as these are an important first step toward a usable psychology of reading instruction. At the most global level, they serve to alert us to the fact that skilled readers do not spring forth "full-blown" at age 6 or 7 and that there are differences between the way beginners attack the task and the way skilled readers perform. They thus warn us against making the assumption that prescriptions for instruction can be derived directly from the characteristics of skilled performance—as the early advocates of whole-word recognition wanted it to do, and as some contributors to the present volumes (e.g., Goodman & Goodman, Vol. 1; Smith, Vol. 2) still appear to recommend. At a more detailed level, developmental studies of reading acquisition can suggest performance rules that may be directly taught or that may serve as a basis for diagnostic instruments for monitoring and guiding instruction. But cross-age comparisons alone cannot provide a firm foundation for instruction, because such studies can neither deal directly with transitions in competence nor establish reliably that observed stages of reading skill are characteristic of each *individual's* development.

Contrastive Studies of Good and Poor Readers. An approach that complements cross-age comparisons, by focusing on differences in skill rather than differences in age, is one that compares the reading processes of individuals of the same age whose reading ability differs. In these studies, good and poor readers are compared on various component processes of word recognition or text processing. This is a very common research strategy in the psychology of reading; a list of studies comparing good and poor readers could easily fill several pages. The work of Perfetti and Lesgold (Vol. 1) on "automaticity" of word recognition is an example of this research strategy. Perfetti and Lesgold show that people who do well on reading comprehension tests (good readers) recognize words more quickly than people who do poorly on comprehension tests (poor readers). Both groups can read the words correctly; yet a reliable difference in speed of recognition exists. Perfetti and Lesgold argue that the extra time needed by the poorer readers shows that they are using a more complicated and less automatic word-recognition strategy than the good readers. This complicated strategy

creates a "bottleneck" in the poorer readers' working memory. That is, since working memory can accommodate only a limited number of operations at once, and since simply recognizing words involves many operations for the poorer readers, the poorer readers have less "space" left for comprehension work than the better, more "automatic" readers do. Lower scores on comprehension tests, the argument goes, are partly the consequence of this overcrowding of working memory.

The finding of automaticity differences, and its interpretation in terms of a working memory bottleneck, would seem to suggest that weaker readers' general reading skill could be improved by providing word-recognition drills in order to increase automaticity. This should free the individual for more comprehension work. This form of instruction has had at least a limited trial; in one study (Fleisher, Jenkins & Pany, 1978), it produced greater speed in word recognition but did not lead to increased comprehension performance. Further experiments are needed, however, before we can conclude that word drill does not foster comprehension. These experiments would need to ensure that the instructional treatment was quite substantial, not just a session or two of practice, as is often the case in laboratory training studies. Furthermore, the practice might be effective largely in helping people to benefit from subsequent *training* in comprehension, not in directly producing improved comprehension performance. Some form of transfer experiment would be needed to test for this kind of indirect effect.

Perfetti and Lesgold anticipated the possibility that automaticity training might not improve comprehension. In doing so, they acknowledged one weakness of contrastive studies: The data collected in such studies are essentially correlational and thus do not permit strong causal inferences. For example, automaticity might *come from* practice in reading meaningful material rather than *fostering* the ability to comprehend what is read. If so, other skills, unspecified in the Perfetti and Lesgold model but essential to effective comprehension, might also be acquired through practice in reading for meaning. In this case, automaticity in recognizing individual words would have to be interpreted as merely a signal that the whole process of learning to read is going well. Such an interpretation, and the instructional practice of providing many opportunities for reading for meaning, would fit well with Chall's (Vol. 1) proposal that a long period of reading familiar materials is required to develop fluency. It would undoubtedly also be congenial to the Goodmans (Vol. 1) and F. Smith (Vol. 2), who argue against any reading instruction that is not clearly oriented toward processing for meaning.

It is important to note in this context another fundamental difficulty in drawing instructional implications from contrastive data. Even when reliable differences in processing can be found, it cannot necessarily be assumed that the poorer readers are simply less advanced than better readers but are on the same developmental track. It is at least possible that good and poor readers

are proceeding along different developmental tracks and that the processes observed or inferred for the less skilled are symptoms of generally less adaptive strategies rather than slower development. This would mean that instruction in any single subskill, such as automatic word recognition, would be unlikely by itself to change weak readers into strong ones, because the observed subskill differences are actually indicators of a whole "package" of differences between good and poor performers. Why some readers might adopt less efficient strategies than others is a question that has barely been raised, and I know of no research addressed directly to it. Some of the authors in these volumes, such as the Goodmans and F. Smith, suggest that too much insistence on overt decoding during early reading instruction may encourage an overly deliberate approach to reading and may actually interfere with the development of more efficient reading processes. To my knowledge, no direct evidence to support such a claim exists, but it is the kind of hypothesis that clearly bears investigation. Such investigations, however, cannot proceed within either a cross-age or a contrastive paradigm, because neither strategy permits direct observation of acquisition sequences. Instead, longitudinal research designs will be required.

Longitudinal Studies of Reading Development. Unlike cross-age and contrastive research, which examine reading processes in steady-state conditions, longitudinal research examines changes in reading processes as individuals, over time, become more competent readers. This approach allows for relatively direct observation of how reading skill develops and how processes such as automatic word recognition, semantic access, and the like are related to reading at various points in development. Longitudinal studies of reading development are rare, however, and it is difficult to find data on the cognitive processes underlying changes in reading performance. A research project currently underway at the Learning Research and Development Center in Pittsburgh may begin to fill this gap. Alan Lesgold, Isabel Beck, and I are conducting a longitudinal study of children in two quite different reading programs: a systematic decoding program developed by Beck (described here by Popp, Vol. 3) and a more eclectic but essentially "whole-word"-oriented basal reading program. When each child reaches a specified point in the instructional sequence, he or she is tested for general visual processing speed, speed of word recognition, and speed of semantic access for both words and sentences (e.g., how quickly the child can decide whether the word "rabbit" or "chair" shown on a screen is an animal). These tests use words drawn from the instructional program that the children have studied and from "transfer" words that conform to the same orthographic patterns as the program words. In addition to these reading process measures, the children's fluency in oral reading and the numbers and types of errors they make are measured, using

texts made up of words they have been taught and transfer words. The time between tests is relatively short; children are usually tested every 2 months or so, depending on their rate of progress through the instructional programs. About 300 children are now being followed in this study. On the basis of this data, we expect to be able to describe individual children's sequences of acquisition in relation to their instructional program and to their progress within the program.

This study has potential for answering several long-debated questions concerning reading instruction. Consider, for example, the question of whether code-oriented instruction prompts children to ignore meaning as they read or, conversely, whether meaning-oriented instruction prompts children to ignore the code and guess at words indiscriminately. There is already some evidence (Barr, 1974-1975) that the reading errors made by children in code-oriented programs are different from those made by children in language-oriented programs. Children in code programs make errors based on orthographic similarity almost from the beginning of their reading instruction, whereas language-oriented learners make these errors later in their development. The Pittsburgh longitudinal study, conducted in two contrasting instructional contexts, will allow us to check on findings of this kind and to draw out their implications for instruction. If children in the Beck code-oriented program make context-based errors as early and to the same extent as children in the basal program (indicating that they are attending to context as much as the basal-taught children), then the claim that code approaches encourage children to ignore context would have to be abandoned. Conversely, if we find that children in the basal program attend to the orthographic structure of words in ways similar to the code-taught children, then the claim that language approaches encourage children to ignore orthography would have to be abandoned.

The general point to be made is that developmental research on reading—whether cross-age, contrastive, or longitudinal—needs to attend to the instructional context in which individuals learn to read. Virtually none of the developmental research on reading up to now has taken into account the nature of the instruction and practice that the individuals being tested have been exposed to. The instructional program is almost never even described (much less analyzed) in developmental studies of reading. Yet it seems quite likely that different instructional programs produce quite different acquisition sequences. To make developmental research more useful to the psychology of reading instruction, we need to relate changes in performance both to the general nature of instruction that children are undergoing and to the exact point they have reached in course of instruction. In other words, we need to treat instructional experience as a crucial independent variable in developmental research on reading.

INDIVIDUAL DIFFERENCES IN READING

Everyone agrees that children do not all learn to read in the same way. The literature on reading instruction is filled with the advice that instruction should be matched to individual differences. This principle seems virtually unassailable. No instruction that fails to take into account what the learner already knows or does not know can possibly be optimal. But beyond the general advice that individual differences should be respected lies a series of largely unanswered questions that the psychology of reading instruction must try to address. Two general approaches to adapting instruction to individual differences can be identified. I call these the "readiness" approach and the "aptitude-matching" approach.

Readiness. A frequently proposed way of respecting the developmental status of the learner is to ensure that instruction is not offered until the learner is "ready" for some new demand or new concept. Nowhere in education is this notion more firmly established than in reading, where reading readiness tests are part of the standard armamentarium of placement and instructional practice at the beginning of school. Reading-readiness testing has traditionally been based on some estimate of general cognitive competence (many of the items on reading-readiness tests are very similar to those on intelligence tests, and the two kinds of tests tend to correlate rather well) and some measure of visual and auditory perceptual skill. The prevailing view has been that children who are not ready by these criteria will fail in learning to read. The evidence for this belief is largely correlational: Reading-readiness tests are reasonably good predictors of performance on reading tests a few years later. Earlier in the 20th century, the prescription for children who did not show adequate readiness had been to delay reading instruction. Thus the implicit definition of respecting developmental level had been that the instructor should simply wait until readiness appears.

Later, partly in response to readiness tests, many kindergartens in fact introduced programs to teach reading readiness. These programs typically taught children to perform the kinds of tasks that appeared on the readiness tests. This tendency to teach the components of readiness rather than wait for them to develop was reinforced by the social pressures and some of the psychological writing of the 1950s and 1960s. Teaching readiness, rather than just waiting for it to develop, was in keeping with the proposal, originally made by Hunt (1961), that matching instruction to developmental level should properly consist of presenting children with tasks that were slightly beyond their current level of competence—enough beyond to provide a challenge but not so far beyond as to provide no base for constructive cognitive activity.

But teaching readiness skills for reading will prove fruitful only if the skills taught are in fact important in learning to read. Readiness tests validated on the basis of how well they predict later success or failure may be misleading in this respect. Consider, for example, the ability to name the letters of the alphabet. This has traditionally been assessed by nearly all readiness tests, and it does predict later success in learning to read. But naming the letters is not needed for reading. Distinguishing one letter from another is needed, and so is knowing their sound values, but knowing their names is not. Knowing the names prior to entering first grade correlates with exposure to and discussion of printed material during the preschool years and probably for that reason predicts reading success. But teaching children the letter names in the absence of other attention to print and its uses might only marginally improve their chances of learning to read easily. Similarly, although the ability to make precise discriminations among nonspeech sounds (animal sounds, traffic noises) may predict how easily one will learn to read, this may be because the sound discriminations are learned earliest or best by those whose ability to acquire information quickly is greatest—that is, by those children whose general intelligence, by any measure, would test highest. Teaching sound discriminations, unless these discriminations are actually part of the reading process, might do little to improve reading acquisition.

What is needed to pursue successfully the readiness teaching approach is an analysis of the reading task itself in order to identify component or closely related abilities that may be directly instructable. Such task analysis has been undertaken during the past 10 years. Decoding has been analyzed, both logically and empirically, and the incidence of difficulty with particular components of the task has been examined. This line of work is well reflected in these volumes; indeed, certain chapters are models of instructionally relevant psychological research on readiness. Liberman and Shankweiler (Vol. 2), for example, have noted that learning the alphabetic code requires the mapping of graphemes to phonemes but that phonemes are a unit of speech smaller than that to which we normally attend. It seems likely, therefore, that many individuals—particularly young children—might have difficulty in segmenting the speech stream into phonemic units (e.g., hearing the *a* as a separate sound in the word *bar*). This indeed turns out to be the case (a finding echoed by other investigators including Calfee, Chapman, & Venezky, 1972; Rosner, Vol. 2; Wallach & Wallach, Vol. 3). Liberman and Shankweiler propose direct instruction in segmentation for individuals found to be weak at it; they describe one such instructional program, developed in the Soviet Union, and refer to other programs prepared with similar principles in mind.

What is required to complete this line of research and reasoning is to demonstrate that learning to segment does facilitate learning to read.

Preliminary evidence that such instruction can not only improve segmentation ability but transfer to learning to read is offered by a study of Rosner's (1971). Gleitman and Rozin (1973) proposed a less direct attack—one that begins reading instruction by requiring a mapping at the syllable level, and only later introducing a grapheme-by-grapheme (and therefore phoneme-by-phoneme) analysis. Others (for example, Beck & Block, Vol. 1; Wallach & Wallach, Vol. 3) propose that the same deficit can be dealt with by highly structured beginning reading instruction that explicitly associates phonemes with graphemes, thus providing curricular assistance to those children who would ordinarily have the most difficulty with segmentation. All of these approaches seem to be logical ways of addressing children's difficulties with segmenting the speech stream. From a theoretical point of view, separate instruction in segmentation that is then shown to transfer to reading is the most interesting approach, because it shows clearly that segmentation is a component of learning to read. From a strictly practical point of view, however, the three approaches are of equal potential interest, and decisions among them will have to be based on instructional simplicity, cost, and efficiency. Meanwhile, other aspects of readiness—especially those connected with general oral-language competence—need to be attended to with the same kind of experimental care that has characterized work on segmentation.

Aptitude Matching. A second way of adapting to individual differences is to attempt to match a general instructional strategy to an individual's particular style or aptitude for learning. This approach assumes that individuals have characteristic differences in abilities or in approaches to learning that are sustained over time and across tasks. One adapts to these differences by seeking instructional methods that capitalize on strong points and minimize dependence on weaker abilities. Effective aptitude matching should produce interactions between measured aptitudes and instructional treatments: People with one set of aptitudes should do best under one instructional treatment; people with a different set of aptitudes should prosper most under a different instructional treatment.

There is notably little discussion in these volumes of aptitude-treatment interactions. Perhaps this is because so little of the psychological research on reading acquisition has proceeded in the context of known instructional treatments. For example, despite a traditional belief among reading specialists that children with "visual" styles of learning should be taught differently from those with "auditory" styles (see Bateman's discussion, Vol. 1, of work on modality differences), there appears to have been little empirical support for this notion over the years, and the issue is barely mentioned in these volumes. What is suggested in a number of the more applied chapters is that children with generally weak cognitive skills may profit particularly from

structured code teaching in the initial grades, whereas for more generally competent children the method of teaching makes little difference. The general argument is that unstructured teaching, such as in language-experience approaches, depends heavily on prior learning, and we can therefore expect outcomes to be highly correlated with measured general intelligence; this correlation can be reduced by use of a more structured and direct teaching approach. This suggestion is in general accord with Cronbach and Snow's (1977) careful review of a portion of the aptitude-treatment interaction literature for reading. Although no single generalization holds for all studies they reviewed, language-experience methods generally showed the highest correlation with intelligence. Other than this rather general finding, the research literature has little to say about aptitude-treatment interactions. Defining aptitudes in terms of the processes known to be involved in reading and then exploring the interaction of these aptitudes with specific instructional methods is a future task for the psychology of reading instruction.

INVENTION AND DISCOVERY IN LEARNING TO READ

The notion of aptitude-treatment may help us to deal more sensibly with an issue that often provokes heated argument among reading specialists but that is only rarely posed as a question related to individual differences. The issue involves the extent to which all aspects of reading must be taught directly. Several contributors to these volumes (e.g., Frederiksen, Vol. 1; Goodman & Goodman, Vol. 1; Chomsky, Vol. 2; Smith, Vol. 2) argue that all or much of the alphabetic code can be learned without direct instruction. Others (e.g., Bateman, Vol. 1; Rosner, Vol. 2) believe that only direct instruction ensures that children will learn this essential aspect of reading. Almost everyone who has taught reading has encountered striking examples of children who appeared to "teach themselves." Exposed to a rich diet of written material, given the opportunity to play alphabet games in which sounds are associated with letters, and encouraged to ask questions about what words and letters "say" and how words are spelled, these children seem suddenly to be able to read. They acquire the code without anyone's having systematically taught it to them, and they quickly delve into reading for meaning and pleasure. Other children don't make such a startling breakthrough but do appear to catch on to it after some time in an instructional program that does not emphasize the code. It seems reasonable to say that these children are "inventing" or discovering reading processes. They are told or shown some of the principles of print-sound relationships; with this as a basis, they construct for themselves a system that can decipher most of the words they encounter. Once

they catch on to the idea of orthographic and phonemic patterning in the written language, they don't need to be taught every orthographic pattern.

There seems to be little doubt that for many children learning to read is primarily an invention or discovery based on relatively small amounts of external direction. But to what extent can reading instruction afford to depend on children's inventions? This question lies at the heart of the psychology of reading instruction, because the answer to it will prescribe how much and what kinds of instruction must be offered to which kinds of children. To explore this question of direct instruction versus invention, we need to answer questions about what is invented and what prior knowledge enhances the likelihood of invention, as well as the central question of who is likely to be inventive.

What Is Invented? Does what is invented in the course of learning to read vary idiosyncratically from child to child, or is there considerable regularity among children? Chomsky (Vol. 2) has collected evidence that some children invent systematic patterns of spelling even before they know how to read. Furthermore, there is striking regularity in the spelling conventions that these children adopt. How widespread is this phenomenon? Does it exist in other geographic regions and among other types of families than those Chomsky studied? Furthermore, is there the same regularity in the case of reading? Do children invent the same processing units, discover the same rules as one another? Do they develop the same strategies for recognizing words and for deriving meaning from the text, or are there large individual differences that might affect instructional decisions? These are some of the questions that the psychology of reading instruction needs to address.

What Kinds of Already Established Knowledge or Skill Enhance the Likelihood of Invention? Is there some information about the code, some set of rules for analyzing print, that is relatively easy to teach and easy for the learner to transform into rules or processes that we know are part of the acquisition sequence? LaBerge (Vol 3), for example, suggests that learning "context nodes"—the size of units to look for—may prepare the learner to acquire the specific associations of graphemes to phonemes. We need instructional experiments that establish context nodes for learners and that study their effects. The point is that we may not need to teach all children everything about reading. Good teaching may be more a matter of drawing attention to certain characteristics of words or letters than of teaching exactly how to analyze them. An easily communicated rule that is not very efficient to use (e.g., soft *c* before *e* and *i*, hard *c* otherwise) may "set a child up" to invent a more efficient performance rule after enough practice. If we view learning as, in part, a process of invention, deciding what to teach becomes more complex

than simply analyzing task performance. The job includes finding rules that invite further elaboration by the learner.

Who Is Likely To Invent and Who Seems To Need Very Explicit Instruction? This is clearly the most important issue in terms of current instructional applications. The question is whether there is a general tendency, differentially present in different children, to invent for oneself or not to do so, so that instruction can be matched in advance to this "trait." It is worth noting that many people argue that the central characteristic of the "hard to teach" (see especially Bateman, Vol. 1; Rosner, Vol. 2), including both compensatory populations (the poor and minority groups) and the learning disabled, is that they cannot be depended on to do much invention, but instead they require a great deal of direct instruction. This assumption seems to underlie the programs that have been most successful with both groups of children. It appears that the best way (statistically speaking) of teaching a child who is labeled compensatory, learning disabled, or mildly retarded to read is to use a direct-instruction code program. (See my review of the evidence for this claim in Vol. 2.) But can we not go beyond this kind of statistically based prescription and assess the need for direct instruction on a more individual basis?

In particular, I believe that we ought to question whether children from poor and minority families should be automatically treated as "hard to teach"—that is, as if they cannot invent much of the reading process for themselves and so, like special-education populations, must be slowly and patiently tutored in every component of the reading process. In recalling this question, it is useful to consider how the "hard-to-teach" label came to be applied to both compensatory and special-education populations. As Bateman (Vol. 1) points out, assessing the specific difficulties shown by children who do not learn to read on schedule suggests similar patterns in the special-education and compensatory groups: Both have difficulty with auditory blending and phonemic segmentation; both sometimes have difficulty forming phrases and sentences after painfully sounding out the individual words; and both seem to have difficulty using the alphabetic coding of the written language unless it is directly pointed out in the course of instruction. Thus both groups seem to be hard to teach, and in similar ways. From this observation, it seems a natural step to the assumption that compensatory populations and special-education populations (especially the learning disabled) should be treated in the same way.

But let us reconsider for a moment. If a child does poorly on a phonemic segmentation task at the age of 5 or 6, it may be because that child has had little exposure to the task before (few alphabet books at home; no sound analysis games around the dinner table, etc.), or it may be that, despite

exposure, the child has failed to catch on to the basic principle. In the first case, we would expect the child to respond quickly to the opportunity to engage in these tasks; it would take relatively few "trials," to use a term from learning psychology, for him or her to learn the tasks, and transfer to new sounds or new phonemic contexts might be very fast. In the second case, learning would proceed slowly, many trials would be needed, and little transfer might occur. Two children might, in other words, start out in the same position, but one would show a steep learning curve, the other a flat and extended one. Both children could, with enough patient instruction and practice, reach "criterion," but we would not be likely to consider them equally difficult to teach. Similar differences in learning rates—for children who have virtually identical entering subskill profiles—might be found for learning new grapheme-phoneme correspondences, blending, recognizing phrase boundaries in order to segment a text meaningfully, and the like. Those who acquire each new aspect of reading quickly and who seem to transfer what they learn to new vocabulary or text with little or no direct instruction are probably children who lacked exposure but not learning ability. Such children are not hard to teach in the sense of not being able to invent. They are (if they can be shown to exist) simply children who have not yet been well taught.

The possibility exists, then, that the group we label compensatory may have within it both children who are truly hard to teach and children who are—in terms of ability—easy to teach but as yet untutored. Here, then, is another fundamental question for the psychology of reading instruction. Starting with a group of children who according to tests lack the same prerequisites of reading, can we develop measures of learning rate and learning processes that will distinguish between individuals who learn quickly once a principle is pointed out and minimal practice is provided and individuals who need extensive teacher-directed practice? If this kind of discrimination can be made for some component of reading, we will then be able to ask whether children who learn that component easily also tend to learn other aspects of reading easily. Do some children, in other words, possess a general ability to learn easily, even though they lack certain knowledge or skill at the beginning of instruction? If we can distinguish, within populations now labeled simply compensatory, those who learn quickly with minimal help from those who need long-term direct instruction in virtually every component of reading, we will have taken a giant step toward turning a socioeconomic definition of a population into a psychological one. In so doing, we will have opened the way for instruction that makes full use of individuals' learning abilities whatever their social group. To make such discriminations, however, we will have to turn from assessments of individuals' current capabilities to assessments that directly consider learning itself.

CONCLUSION: REUNITING COGNITIVE AND LEARNING PSYCHOLOGY

In the preceding paragraphs I have quietly introduced some concepts and language that seem closer to the learning psychology of a decade or two ago than to the language and models of contemporary cognitive psychology. I spoke of learning curves and learning rates not to demonstrate that one *could* deal with questions of reading in these more traditional terms, but because these concepts seem *necessary* to answer critical questions concerning instruction. It is in the context of such instructional questions that the cognitive branch and the learning branch of psychological research can fruitfully interact. The resulting cognitive learning psychology, which is required if psychology is to prove useful for instruction, will need to attend to questions of the kind raised here.

We must, as I have suggested, learn a great deal more about the relationship between skilled performance in reading and patterns of its acquisition. Therefore we must enlarge and extend developmental research in reading. We must also—and this is both the larger and in many respects the newer question—learn how development is modified by certain kinds of environmental events, particularly those we call instruction. A view of learning that acknowledges the learner's role in constructing his or her own knowledge and skill must be joined with an analysis of the environmental events that can foster—or hinder—such constructions. We cannot choose between a constructive learner operating in an undifferentiated environment and a passive "receptacle" of knowledge whose environment is structured to provide all needed information. We must begin to take the notion of *interaction* between learner and environment quite seriously, specifying features of the environment that interact with characteristics of the learner's knowledge and processes to produce transitions in cognitive competence. Finally, the new psychology of reading instruction that I envisage will be highly attentive to individual differences, seeking to explain and predict the effects of instructional environments on individuals characterized in terms of their psychological processes of learning and their cognitive performance.

Sustained attention to questions of this kind will not only teach us about reading and reading instruction; it will also directly contribute to the development of a cognitive theory of learning. The new psychology of reading instruction, in other words, must be grounded in and part of cognitive, learning, and developmental psychology. It cannot simply apply to reading the established methods of those branches of psychology. Instead it must pursue the logic of its own questions. In the process, it may change the face of its parent disciplines.

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